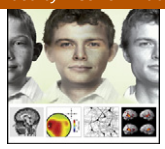
Developmental Cognitive Neuroscience 1 (2011) 256–259

Developmental Cognitive Neuroscience

journal homepage: http://www.elsevier.com/locate/dcn



Understanding the neural response to social rejection in adolescents with autism spectrum disorders: A commentary on Masten et al., McPartland et al. and Bolling et al.

Catherine L. Sebastian[a,b], Sarah-Jayne Blakemore[b,*]

[a] Clinical, Educational and Health Psychology, University College London, 26 Bedford Way, London WC1H 0AP, UK
[b] Institute of Cognitive Neuroscience, University College London, 17 Queen Square, London WC1N 3AR, UK

ARTICLE INFO

Article history:
Received 31 March 2011

Achieving social acceptance and avoiding rejection by peers are strong motivational goals during development, particularly during the period of adolescence (Sebastian et al., 2010). Autism spectrum disorder (ASD) is a developmental disorder characterised in part by problems with social interaction. Individuals with high-functioning ASD report a desire for friendship (Frith, 2004); however, they also experience greater levels of loneliness (Bauminger and Kasari, 2000) and bullying from peers (Van Roekel et al., 2010) than do their typically developing (TD) peers, most likely due to poor social skills. Only a small number of studies have addressed how individuals with ASD experience social rejection. Three studies in the current issue address this question in children and adolescents with ASD.

One previous experiment (Sebastian et al., 2009) investigated reactions to rejection in high-functioning ASD, using an experimental social rejection manipulation paradigm known as 'Cyberball' (Williams et al., 2000). This is a computerised ball tossing game in which participants can be systematically included or excluded from the game by other 'players' whose actions are actually pre-programmed by the experimenters. Adolescents with ASD and TD matched controls (mean age 16.9 years) were first included by the other players, and then excluded (rejected). Before playing Cyberball, and then after inclusion and exclusion conditions, participants rated their levels of social distress, current anxiety and mood. Both ASD and TD participants reported increased distress following rejection; however, only TD participants reported lower mood compared with baseline and inclusion conditions. This suggested that, while social distress during rejection is largely preserved in ASD, some differences do exist. As no physiological measures were taken, it was not possible to determine whether the mood effect was due to group differences in the experience of social rejection, or due to poor interoceptive awareness in the ASD group, which might have prevented these participants from accurately reporting lowered mood (Ben Shalom et al., 2006; Silani et al., 2008). A related point is that it is not possible to know how self-report measures about mood and anxiety are understood by individuals with ASD. They might be reporting what they believe is expected of them; or they might have learned that social exclusion is 'bad' and answer the self-report questions accordingly. Thus, differing cognitive processes might underlie similar self-reported responses.

The possibility that physiological factors may underlie differential behavioural responses to social rejection and acceptance in ASD was investigated in a recent study by Andari et al. (2010). This study found that intranasal administration of oxytocin normalised otherwise atypical responses during a modified Cyberball paradigm in adults

DOIs of the original articles:10.1016/j.dcn.2011.01.004, 10.1016/j.dcn.2011.02.003, 10.1016/j.dcn.2011.02.002.
* Corresponding author.
E-mail address: s.blakemore@ucl.ac.uk (S.-J. Blakemore).

1878-9293/$ – see front matter
doi:10.1016/j.dcn.2011.03.006

with ASD. Without oxytocin, and in contrast to TD controls, participants with ASD did not differentiate between players who included or excluded them in terms of the number of balls participants threw to the other players, or on self-reported measures of trust and preference. Following oxytocin administration, however, a preference for players who included the participant emerged. Oxytocin modulates the function of a wide network of socioaffective brain regions (Kirsch et al., 2005; Baumgartner et al., 2008), and it is possible that there are neural differences in the processing of social rejection cues between ASD and control groups. However, the precise neural underpinnings of these effects were not addressed directly. In the current issue of DCN, three studies used neuroimaging methods to address directly the question of whether the neural bases of responses to rejection differ between children/adolescents with ASD and TD controls.

Masten et al. (in this issue) report an fMRI study in which they compared neural responses to social rejection in 19 high-functioning adolescents with ASD (mean age 14 years) and 17 TD controls (mean age 13.6 years). In previous fMRI studies using the Cyberball paradigm, TD adolescents have shown neural responses to rejection in brain regions associated with affective distress (subgenual anterior cingulate, anterior insula), and affect regulation (ventrolateral PFC, ventral striatum) (e.g. Masten et al., 2009; Sebastian et al., in press). The current study replicated these findings in TD adolescents, and found attenuated responses to exclusion in these regions in the ASD group. However, in line with our previous behavioural study, self-reported levels of distress following rejection were equivalent across groups.

A similar result was reported by McPartland et al. (in this issue), in which event-related potentials (ERPs) were used to explore the temporal dynamics of neural responses to rejection during Cyberball in 20 high-functioning children and adolescents with ASD (mean age 10.2) and 34 TD controls (mean age 11). In line with our previous study (Sebastian et al., 2009) and with Masten et al., both groups reported similar levels of distress following rejection. However, the ERP data revealed group differences in neural processing during the games. In response to rejection events (relative to 'not my turn' events within the inclusion condition), the TD group showed an enhanced late slow wave negativity over medial-frontal scalp electrodes which correlated with self-reported mood and distress. The ASD group did not show this response, but in contrast showed attenuation of an early frontal positivity (P2) component. As the frontal P2 is associated with selective visual attention (Key et al., 2005), the authors suggest that its attenuation in the ASD group may reflect reduced engagement of attentional resources during rejection, although it is not clear why this should be the case. Thus, it may be that differing neural strategies underlie similar self-reported reactions to negative social situations in ASD, and that different cognitive strategies underlie similar behaviour (at least as measured by self-report).

In the third study, Bolling et al. (in this issue) used fMRI to compare neural responses to social rejection and reactions to rule violation in 24 high-functioning individuals with ASD (mean age 12.81) and 24 age- and IQ-matched controls (mean age 12.83). Since individuals with ASD exhibit restricted and repetitive behaviours, Bolling et al. hypothesised that self-reported distress following rejection in ASD may be driven by reactions to rule violation (in that participants expect to be thrown the ball, but are not (Somerville et al., 2006)), rather than by social distress. Social rejection was manipulated using an adapted version of Cyberball, while a comparable game without an exclusionary element (Cybershape) was used to probe responses to rule violation. In line with predictions, and replicating the findings of Masten et al. (in this issue), the right insula and ventral ACC were hypoactive in response to social rejection in children and adolescents with ASD (relative to controls). Interestingly, participants with ASD found the rule violation condition more distressing than did TD participants and also showed increased activity in response to rule violation (relative to controls) in a more anterior region of the right insula and in dorsal PFC. Previous studies have shown hypoactivation of the anterior insula during social cognition tasks in ASD (Di Martino et al., 2009). However, the authors conclude that this region is not definitely dysfunctional in ASD, but that the context in which it responds may differ between ASD and TD individuals.

Overall, what have we learned from these three new studies? First, the behavioural data across all three studies replicate the findings from our behavioural study (Sebastian et al., 2009): individuals with ASD and TD controls report comparable levels of distress (using written self-report questionnaires) following social rejection in the Cyberball game (although since self-report can be susceptible to biases and expectation, alternative explanations cannot be ruled out). Second, the three studies suggest that, despite similarities at the self-report level, the way in which social exclusion is processed at the neural level differs between ASD and TD groups. Results across the three studies are broadly consistent in showing hypoactivity in regions associated with social distress and its regulation in ASD. This may relate to our previous finding of reduced effects of social exclusion on mood in ASD. Specifically, reduced or atypical neural processing of social rejection may have contributed to the observed lack of self-reported mood modulation in ASD (although an additional role for reduced introspective ability cannot be ruled out).

What could explain the apparent dissociation between self-reported distress and other affective indices including mood (our previous study), trust and preference (Andari et al., 2010) and responses to rejection in affective brain regions (the three current studies)? The study by Bolling et al. provides an interesting insight. Results from the Cybershape rule violation paradigm found that participants with ASD found the rule violation condition more distressing than did TD participants. Since the exclusion condition in Cyberball also includes an expectation violation component, it may be that rule violation, rather than the social nature of the rejection, is driving self-reported distress in the ASD group. Thus, the pattern of similar self-reported distress in the context of differing neural responses to social rejection may reflect differing (but no less acute) sources of distress between the two groups.

However, we would suggest that, while rule violation may provide an additional source of distress during social

rejection in ASD, social responses to rejection seem to be at least partially preserved. This is suggested by the specifically social nature of the Need Threat questionnaire (Williams et al., 2000) used to assess distress following exclusion in all the above studies (typical items ask participants to rate the extent to which they felt they belonged to the group, or felt liked by other players). Additionally, there is evidence that adolescents with high-functioning ASD report higher levels of social anxiety than their TD peers (Kuusikko et al., 2008), more depression generally (Hill et al., 2004), and that those reporting low levels of peer group membership also report higher levels of depressive symptoms (Hedley and Young, 2006). These effects are unlikely to be due to solely non-social aspects of the rejection experience, although the possibility that a general feeling of non-social distress could be picked up by social questionnaires cannot be conclusively ruled out without further empirical study. Additionally, since it is unknown whether self-report measures used in these studies were understood in the same way by both groups, future research should aim to investigate how individuals with ASD understand the meaning of words like distress, anxiety and mood.

There are certain methodological aspects of the Cyberball paradigm that differ between studies and that warrant further discussion. For example, in two of the studies (Masten et al. and McPartland et al.), participants played two relatively long games of Cyberball in a fixed order (inclusion followed by exclusion), whereas Bolling et al. used short, alternating blocks of inclusion and exclusion. The former method increases ecological validity at the expense of experimental control, while the reverse is true for the latter method (see Sebastian et al., in press, for a discussion of these issues). Encouragingly, results from the three studies are consistent with each other and with previous neuroimaging studies of social rejection in adolescence, which have themselves used a variety of methods (e.g. Bolling et al., 2011; Masten et al., 2009; Sebastian et al., in press). This suggests that these varied task designs tap the same underlying neural circuitry subserving both affective and regulatory responses to social rejection.

It is worth noting that all studies investigating social rejection in ASD to date have studied high-functioning individuals only, and therefore applicability to lower-functioning ASD is unknown. Additionally, the three current studies did not take self-report measures following inclusion or at baseline (before playing Cyberball), and so it is unknown whether levels of distress and mood were comparable between groups before exclusion took place. This may at least partially explain some inconsistencies between studies; for example McPartland et al. did not find group differences in mood following exclusion, which might appear to contradict our previous study. However, our study also showed no group difference in mood ratings following exclusion; rather, a significant decrease in mood between baseline/inclusion and exclusion conditions in the TD group was not seen in the ASD group. It is important to note that these issues do not affect interpretation of the neuroimaging data, since all studies contrasted neural responses to exclusion with inclusion.

An interesting implication of these three studies is that the use of neuroimaging methods can extend our understanding of behaviour in clinical groups beyond that provided by behavioural studies alone. These additional insights into differing social processing mechanisms in ASD might ultimately inform intervention strategies. Of specific relevance to social rejection, such interventions should aim to boost coping skills when social rejection occurs – this is an ambitious goal, and of course not only relevant to individuals with ASD. The current studies suggest that it may be preferable to address the causes and consequences of social rejection obliquely. For example, the study by Bolling et al. suggests that it might be particularly fruitful to direct coping strategies towards regulating distress associated with rule violation or perceived unfairness. The ability to manage the resulting frustration and distress could then feed into efforts to improve reciprocal social interaction skills.

In summary, the picture is more complex than a case of responses to rejection simply being either 'preserved' or 'deficient' in ASD. It appears that, while the self-reported effects of social rejection are similar between individuals with ASD and typically developing controls, the neural circuitry involved in the typical response to rejection (compared with inclusion) is hypoactive in ASD. Since these effects were seen in both affective and regulatory regions, it would be interesting to explore whether connectivity between these regions is also altered in ASD. Additionally, while all studies to date have relied on self-report data, future studies should supplement this with physiological measures such as skin conductance response (Ben Shalom et al., 2006), heart rate (Gunther Moor et al., 2010) or pupillometry (Silk et al., in press). The current studies significantly extend our understanding of responses to rejection in ASD, and may facilitate the development of strategies for coping with social rejection and improving social skills in this population.

Acknowledgements

SJB is funded by the Royal Society and the Leverhulme Trust, UK. We thank Iroise Dumontheil and Hauke Hillebrandt for their helpful comments on the manuscript.

References

Andari, E., Duhamel, J.R., Zalla, T., Herbrecht, E., Leboyer, M., Sirigu, A., 2010. Promoting social behavior with oxytocin in high-functioning autism spectrum disorders. Proceedings of the National Academy of Sciences of the United States of America 107, 4389–4394.

Baumgartner, T., Heinrichs, M., Vonlanthen, A., Fischbacher, U., Fehr, E., 2008. Oxytocin shapes the neural circuitry of trust and trust adaptation in humans. Neuron 58, 639–650.

Bauminger, N., Kasari, C., 2000. Loneliness and friendship in high-functioning children with autism. Child Development 71, 447–456.

Ben Shalom, D., Mostofsky, S.H., Hazlett, R.L., Goldberg, M.C., Landa, R.J., Faran, Y., et al., 2006. Normal physiological emotions but differences in expression of conscious feelings in children with high-functioning autism. Journal of Autism and Developmental Disorders 36, 395–400.

Bolling, D.Z., Pitskel, N.B., Deen, B., Crowley, M.J., McPartland, J.C., Kaiser, M.D., et al. Enhanced neural responses to rule violation in children with autism: a comparison to social exclusion. Developmental Cognitive Neuroscience, in this issue.

Bolling, D.Z., Pitskel, N.B., Deen, B., Crowley, M.J., McPartland, J.C., Mayes, L.C., et al., 2011. Dissociable brain mechanisms for processing social exclusion and rule violation. NeuroImage 54, 2462–2471.

Di Martino, A., Ross, K., Uddin, L.Q., Sklar, A.B., Castellanos, F.X., Milham, M.P., 2009. Functional brain correlates of social and nonsocial processes in autism spectrum disorders: an activation likelihood estimation meta-analysis. Biological Psychiatry 65, 63–74.

Frith, U., 2004. Emanuel Miller lecture: confusions and controversies about Asperger syndrome. Journal of Child Psychology and Psychiatry 45, 672–686.

Gunther Moor, B., Crone, E.A., Van der Molen, M.W., 2010. The heartbrake of social rejection: heart rate deceleration in response to unexpected peer rejection. Psychological Science 21, 1326–1333.

Hedley, D., Young, R., 2006. Social comparison processes and depressive symptoms in children and adolescents with Asperger syndrome. Autism 10, 139–153.

Hill, E., Berthoz, S., Frith, U., 2004. Brief report: cognitive processing of own emotions in individuals with autistic spectrum disorder and in their relatives. Journal of Autism and Developmental Disorders 34, 229–235.

Key, A.P., Dove, G.O., Maguire, M.J., 2005. Linking brainwaves to the brain: an ERP primer. Developmental Neuropsychology 27, 183–215.

Kirsch, P., Esslinger, C., Chen, Q., Mier, D., Lis, S., Siddhanti, S., et al., 2005. Oxytocin modulates neural circuitry for social cognition and fear in humans. Journal of Neuroscience 25, 11489–11493.

Kuusikko, S., Pollock-Wurman, R., Jussila, K., Carter, A.S., Mattila, M.L., Ebeling, H., et al., 2008. Social anxiety in high-functioning children and adolescents with Autism and Asperger syndrome. Journal of Autism and Developmental Disorders 38, 1697–1709.

Masten, C.L., Colich, N.L., Rudie, J.D., Bookheimer, S.Y., Eisenberger, N.I., Dapretto, M. An fMRI investigation of responses to peer rejection in adolescents with autism spectrum disorders. Developmental Cognitive Neuroscience, in this issue.

Masten, C.L., Eisenberger, N.I., Borofsky, L.A., Pfeifer, J.H., McNealy, K., Mazziotta, J.C., et al., 2009. Neural correlates of social exclusion during adolescence: understanding the distress of peer rejection. Social Cognitive and Affective Neuroscience 4, 143–157.

McPartland, J.C., Crowley, M.J., Perszyk, D.R., Naples, A., Mukerji, C.E., Wu, J., et al. Temporal dynamics reveal atypical brain response to social exclusion in autism. Developmental Cognitive Neuroscience, in this issue.

Sebastian, C., Blakemore, S.J., Charman, T., 2009. Reactions to ostracism in adolescents with autism spectrum conditions. Journal of Autism and Developmental Disorders 39, 1122–1130.

Sebastian, C., Viding, E., Williams, K.D., Blakemore, S.J., 2010. Social brain development and the affective consequences of ostracism in adolescence. Brain and Cognition 72, 134–145.

Sebastian, C.L., Tan, G.C., Roiser, J.P., Viding, E., Dumontheil, I., Blakemore, S.J. Developmental influences on the neural bases of responses to social rejection: implications of social neuroscience for education. NeuroImage, in press.

Silani, G., Bird, G., Brindley, R., Singer, T., Frith, C., Frith, U., 2008. Levels of emotional awareness and autism: an fMRI study. Social Neuroscience 3, 97–112.

Silk, J.S., Stroud, L.R., Siegle, G.S., Dahl, R.E., Lee, K.H., Nelson, E.E. Peer acceptance and rejection through the eyes of youth: pupillary, eyetracking, and ecological data from the chatroom interact task. Social, Cognitive and Affective Neuroscience, in press.

Somerville, L.H., Heatherton, T.F., Kelley, W.M., 2006. Anterior cingulate cortex responds differentially to expectancy violation and social rejection. Nature Neuroscience 9, 1007–1008.

Van Roekel, E., Scholte, R.H., Didden, R., 2010. Bullying among adolescents with autism spectrum disorders: prevalence and perception. Journal of Autism and Developmental Disorders 40, 63–73.

Williams, K.D., Cheung, C.K., Choi, W., 2000. Cyberostracism: effects of being ignored over the Internet. Journal of Personality and Social Psychology 79, 748–762.